researches in Chemical Mechanics, and the other on Equilibrium in Gaseous Systems. Prof. Terquem, of Lille, will read various papers in Optics and Acoustics, and M. G. Tissandier will give a public lecture on Meteorology and Balloons.

On the whole, there will be a fair number of purely scientific papers, though there is an unusually large proportion in medical and industrial subjects.

## *THE COMETS*

THE following communication appears in the *Times* from Mr. J. R. Hind, F.R.S., dated Mr. Bishop's Observatory, Twickenham, August 10 :—

"I send you positions of the last new comet (Borrelly) for the ensuing ten days ; warning the amateur, however, that he must not expect to see it well without a very good telescope. They are deduced from the following orbit, which I have calculated from the first accurate observation at Marseilles on July 26, one at Strasburg on Aug. 1, received from Prof. Winnecke, and a third taken at Mr. Bishop's Observatory on the 4th :—

"Perihelion passage, August, 27·0861 Greenwich time; longitude of perihelion, 344° 24′ 6″; ascending node, 250° 59′ 50″; inclination to ecliptic, 41° 39′ 52″; distance in perihelion, 0·98090 ; heliocentric motion, direct.

"The subjoined places are for midnight :—

| | Right Ascension. | Polar Distance. | Distance from Earth. |
|---|---|---|---|
| | h. m. s. | ° ′ | |
| Aug. 10 | 14 33 22 | 20 40 | 0·676 |
| ,, 12 | 14 20 44 | 19 47 | 0·684 |
| ,, 14 | 14 7 27 | 18 59 | 0·692 |
| ,, 16 | 13 53 22 | 18 15 | 0·699 |
| ,, 18 | 13 38 18 | 17 36 | 0·705 |
| ,, 20 | 13 22 28 | 17 2 | 0·711 |
| ,, 22 | 13 5 55 | 16 34 | 0·717 |

"The distances are expressed, as usual, in parts of the earth's mean distance from the sun.

"It appears that efforts in various observatories to obtain a daylight view of the late bright comet have been fruitless. I had been most hopeful of it being thus seen with the powerful telescopes and in the favourable climate of Marseilles ; but I learn from M. Coggia that a close search for the comet in fine skies on July 22, and from morning to evening on the 26th, failed to afford a glimpse of it. At Twickenham, under very advantageous circumstances, about noon on July 23, we could not detect it, when Procyon, the principal star in Canis Minor, at nearly the same angular distance from the sun, was shining brightly in the telescope. It affords additional evidence that proximity to the earth is not so important a condition for visibility of a comet in the daytime as close approach to the sun ; but it was very desirable to have the appearance of Coggia's comet upon record."

## *THE FORM OF COMETS**

### IV.

WE have seen then that the phenomena of the tails of comets can be explained even including their most complicated appearances. I now proceed to deal with other phenomena, for the best proof of the truth of a theory is its capacity to explain a multitude of details which were not at first considered. Examine in the figure (Fig. 8) which I recently showed you of Donati's comet, that singular dark portion which is seen in the axis of the tail to a very considerable distance from the nucleus, and say if that cylindrical space, void of matter, is not the effect of the interposition of a screen—the nucleus, which intercepts the repulsive force, and suppresses in this region all the molecules driven from the head of the comet. This is because the repulsive force, being a surface-action, is spent against that of the nucleus, and is arrested by this simple screen ; it is quite the reverse of attraction, which acts effectually through all matter as if that matter did not exist. This cannot have been the shadow thrown by the nucleus, for two reasons, of which it is enough to mention the first : the black streak, besides being much too long, is not in the exact direction of the luminous ray ; it is inclined to the radius vector at an angle of several degrees, for which the theory accounts. In short, it widens considerably when tails almost straight, composed of the rarest materials, are about to disappear, and we can often follow its trace to the extremity of the tail.

But I must dwell, in conclusion, upon the curious phenomena of the head and upon the luminous sectors which usually appear in the direction of the sun. We find here a new confirmation of the play of the repulsive force. Fig. 15 is a drawing on a large scale of the head of the comet of 1861, made at Rome by Father Secchi.

Let us not forget, in what follows, that one of the characteristic features of the nebulous layers which surround the nucleus, and of which it is perhaps entirely composed, is the transparency which permits us to see small stars through depths much greater than that of our atmosphere. There is reason, then, for believing that the solar rays penetrate across these layers to the central nucleus and heat it, all the more since these same layers are probably not so permeable to dark heat as they are to luminous heat. In the space of three weeks the central heat may thus be raised from the degree of heat of distant space to a temperature sufficiently elevated to volatilise a part of the matter of the nucleus, and perhaps promote chemical reactions arrested till then by the original cold.* Under this increasing influence the matter is dilated and rapidly separates from the nucleus (19 metres per second for Donati's comet); but soon this matter, still too dense to be sensibly repelled, reaches the surface limit beyond which it ceases to belong to the comet. This surface limit presents, as we have seen, two opposite conical points by which the emission takes place. At a later period this matter getting further and further away, and becoming more and more rarefied, falls under the action of this repulsive force, which then makes it turn tail and fly to the rear. This species of conical envelope, turned towards the sun, assumes the appearance of a calyx with inverted edges, while the opposite envelope with obscure interior contracts under the influence of the same action, but without changing its curvature. There will be noticed, in front of this species of calyx, exterior strata nearer to the sun, to which they present their convexity instead of being opened out conformably to the theory which M. Roche had hitherto based solely upon attraction. I asked M. Roche to introduce the new force into his investigation of the surfaces assumed by a fluid mass submitted to the double attraction of its own mass and of that of the sun, and we have had the satisfaction of seeing one of the two singular points of the surface limit disappear. The surfaces are completely enclosed and become curved towards the sun ; there is no room on this side for any loss of matter. But this is to be expected in the exterior layers, which have too little density to obey repulsion ; while in the interior of the head, very near the nucleus, attraction still rules exclusively on account of a density still very great.

In order to render these somewhat complicated details of the theory intelligible, we have only to turn round on its axis Fig. 16 ; it will generate a surface of revolution composed of an exterior envelope having a form roughly parabolic, and of two envelopes attached to the nucleus, one of which is, to use a botanical term, of a cyathiform aspect, while the other is almost conical.

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* Continued from p. 270.

* Spectrum analysis seems to prove that this heat may reach the point of giving to the nucleus a light of its own, presenting, moreover, the characteristics of a light emitted by a gaseous substance. But up to the present time (1870), indications of this kind are too vague and too doubtful to enable us to derive much help from them.

If we compare this theoretical figure with that of the head of the comet of 1861 (Fig. 15) and of other comets, it will account for the transparency of these surfaces and for the effects of perspective. The latter are continually changing, for comets are presented to us in all imaginable positions.* The conical anterior envelope is often described by observers under the name of a luminous sector, a term which gives a false idea of its real form. In the head of Donati's comet, the luminous sector appears to have had an amplitude very much greater than that of the comet of 1861.

You see that all the most constant, the best investigated, the most characteristic details of the figure of comets agree in disclosing the action of a repulsive force which is exerted by the sun not in virtue of his mass, but in virtue of his superficial incandescence. Extinguish the photosphere of the sun, reduce it in thought to the state of crust to which cold has long ago brought the earth, so as to leave nothing more than the solar attraction inherent in its mass, indestructible as the mass itself, and you will suppress at the same time the gigantic tails of comets and the cup-shaped emissions of their heads. They will no doubt still lose some part of their materials in approaching the sun, but these materials will be disseminated along the orbit of the comet instead of flying away from the sun into space with an incredible swiftness. In a word, comets would lose the forms represented in Fig. 7, and would assume those of Fig. 6.

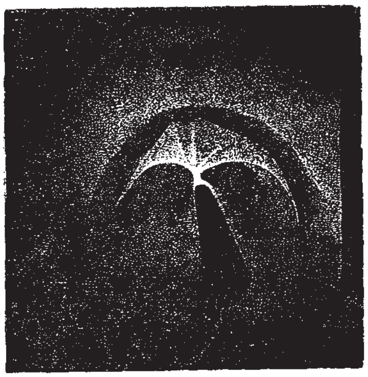

FIG 15.

It may perhaps appear to you singular that we must go to celestial phenomena for evidence of the existence of a force so widespread as repulsion due to heat when it acts at a sensible distance, and not from molecule to molecule. In reality there is nothing astonishing in this; it was the same with attraction.

Each of you is firmly convinced of the existence of this force; you know that two spherical bodies attract each other in proportion to their mass, and in inverse proportion to the square of their mutual distance, and that notwithstanding that you have not had ocular demonstration, that you have not tested it by experiment; around us, within us, nothing announces to us that bodies attract each other. No direct experiment has ever been made on the point in France, and if any physicist set himself to it, he would require six months at least to prepare for what is known in England as the "Cavendish Experiment."

But if attraction produces around us effects so feeble that no mechanician or physicist ever thinks of taking them into account in his experiments and calculations, on the other hand it acts on a grand scale in celestial space on account of the greatness of the masses. Well, it is the same with the force of repulsion; on account of the incandescence of the surface of the sun, of the enormous extent of that surface, and of the small density which matters may acquire, where they have infinite space in which to expand. Although this repulsive force is acting all round us, just like attraction, it is quite as difficult to prove it, because we cannot attain by means of our furnaces the degree of incandescence of the sun, and above all because we operate only upon insignificant surfaces, and because we work in an atmosphere of an enormous density as compared with cometary materials. It is easy to see, then, that to obtain evidence it would be necessary to resort to combinations as delicate as those of the Cavendish Experiment.

We may, however, do this: the repulsive force, with all the characteristics which we have discovered in it, is yet only a hypothesis which accounts at once for the figure of comets and for the acceleration of their motion. We have connected it, it is true, by the incandescence of the sun, with the familiar phenomena of the repulsion determined by heat between the molecules of bodies; but it remains to show, by a direct experiment, the difficulties of which we have seen, that this repulsion exists beyond the infinitely small distance which separates these molecules. This experimental verification of every hypothesis is an essential thing in astronomy; by this alone can our minds be fully convinced. The physicist, on the contrary, can use more largely the convenient artifice of hypotheses, since he holds in his hand, so to speak, the phenomena which he studies, may reproduce them, call them forth at his pleasure, and regard his subjects in all their aspects. Should an hypothesis be found to contradict certain facts, the physicist imagines for them another more comprehensive which he will subject to the same process. It is not so with astronomy. That which has long been wanting to the theory of attraction in the case of many minds strongly prejudiced, moreover, in favour of another doctrine, is precisely this direct and experimental verification the necessity for which I have pointed out. Everybody did not feel, on the appearance of the *Principia*, that it was implicitly contained in the famous calculus which enabled Newton to see that the force which holds the moon in its orbit is identical with that which every-

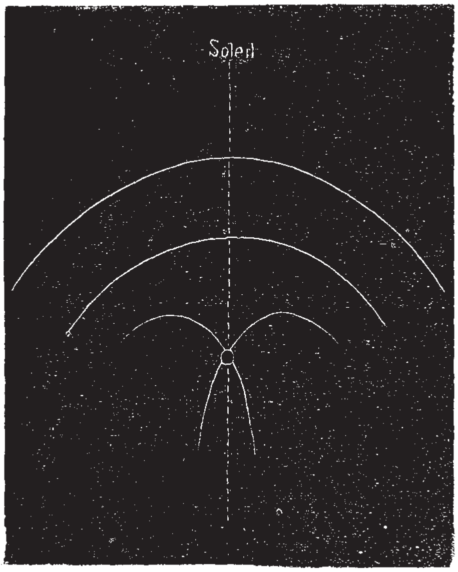

FIG. 16.

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* Moreover, the least want of homogeneity in the nucleus and a rotatory movement may considerably modify the phenomena and leave only the narrow part of the anterior calyx. But these anomalies do not take away from the phenomenon its characteristic physiognomy, even when they give, for example, to the anterior calyx, a most curious radiated aspect.

where causes bodies to fall to the ground. The learned opponents of the doctrine on the Continent would, without doubt, have been favourably disposed to it before the experiment of Cavendish or that of Maskelyne, if Newton had been able to realise to them so as to show to all eyes that bodies of suitable form and of any nature whatever attract each other in proportion to their mass and in the inverse ratio of the square of their distance.

But how are we to apply the Cavendish balance to the measurement of the repulsive force of an incandescent surface? First of all, the materials of our apparatus are of a density enormously superior to that of comets; then it is necessary to operate in a perfect vacuum, for the least trace of air which remains in the apparatus will give rise to currents under the influence of a surface strongly heated, and will thus obscure the effect which we endeavour to establish. In trying to surmount this difficulty,* I have been led to think that if I could make an incandescent surface act upon the small mass of air itself which acts as an obstacle to us in the vacuum of our best pneumatic machines, I should obtain a very appreciable repulsion; only we must find some means of rendering this air visible. The artifice to which I am about to have recourse before you consists in illuminating this rarefied air by means of the spark of Ruhmkorff's induction apparatus. (See Fig. 17.) This glass bell-jar, in which a vacuum has been made, is traversed by the two conductors of the apparatus, the one vertical and the other horizontal. You see the spark spring out under the form of feebly luminous stratifications of a peculiar rose colour; at the same time the horizontal conductor is covered with a luminous sheath of a well-marked blue colour. It is the air which is thus illuminated by the passage of the current. Remark, however, the particular form of the horizontal wire; it is formed partly of a thin blade of platinum surrounded by a blue aureole. I shall redden this plate by means of an ordinary current, composed of several Bunsen couples. I cause this current to pass through the horizontal conductor, not disturbing in the least the first induction current. The platinum plate becomes incandescent, and you soon see the blue-coloured sheath separate from the platinum plate like two lips which are parted.

I have varied this experiment to obviate the objections to which the increase of the conductibility of the air might give rise; but it has always succeeded. Thus have I obtained an analogous repulsion by acting transversely upon the rose-coloured stratifications; the case was absolutely the same as if a perfect vacuum existed around the plate, a vacuum of definite limits beyond which the electricity would not pass, while an increase of conductivity would simply cause the induction-spark to incline towards the favourable region and so to modify its usual configuration.

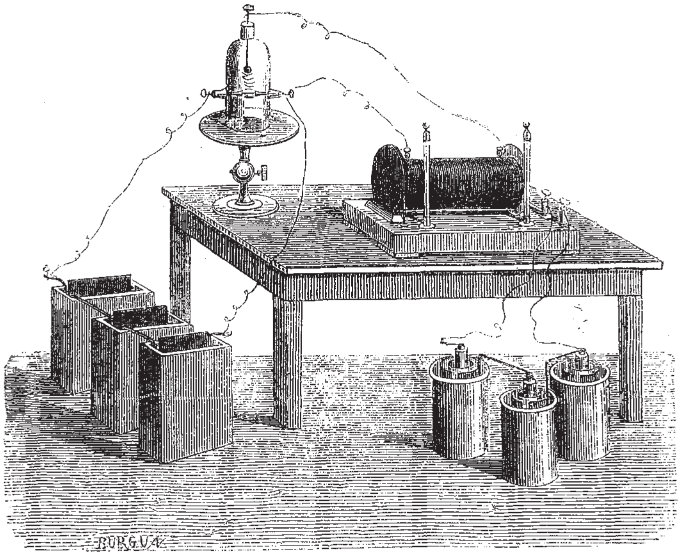

Fig. 17.

Thus have we been led to conclude with perfect certainty (1) that cometary phenomena reveal to us in the universe the existence of a second force totally different from attraction, capable of playing an important part and producing before our eyes gigantic phenomena; (2) with great probability, that this force is nothing else than the repulsion due to heat.

Perhaps we may come upon this force when we investigate more closely the strange phenomena of the solar protuberances which the brilliant discovery of Janssen and Lockyer permits us henceforth constantly to follow, or when science will be in a condition to approach the investigation of those mysterious star clusters which attraction has not been able to unite into a single sun, and which appear to us under forms so strange and withal so geometric.

Whatever may be the value of these experiments, it is of importance, I believe, to science, not to leave this beautiful question of the figure of comets without any other answer than the *je ne sais* of Arago, and it is of not less importance to natural philosophy to prove that the forces which rule the stars are none other than those which act around us at the surface of the earth. If it should displease any sage metaphysician that I have tried to establish a duality of forces in a region where he vainly flattered himself that unity reigned, I pray him to consider that, if it is possible to transform, so to speak, certain forces into each other, to produce, for example, heat by means of the concussion of a body acted on by terrestrial attraction, then electricity by means of this heat, magnetism by means of this electricity, and finally to attract a very peculiar sort of matter by means of this magnetism, we have not succeeded in the least in transforming the attractive force of the least molecule, since its weight remains invariable through all the modifications of the forces which act upon it. The desired unity, then, was far from being realised before the appearance of that repulsive force acting at a distance which the cometary phenomena definitely inscribe in the mechanism of the heavens by the side of attraction, and which I find around us in the phenomena of heat.

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* We could assuredly manage it, but it would be necessary to have at our disposal means of execution superior to the resources of a private individual.

At all events, we have got a great way from that judicial astrology which I felt bound to remind you of at the outset, in order to show to you the condition in which we found that branch of celestial science. While, in planetary astronomy, scarcely anything has been done for two hundred years but to develop indefinitely the mathematical formulæ of a force established and defined, we have tried here to put ourselves on the track of a force which rules more especially the cometary world, and have endeavoured to give it a name.

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## *THE AMERICAN OYSTER-TRADE*

SOME notion of the extent of the trade in oysters at Baltimore may be gathered from a recent report of the British Consul. Baltimore, it is said, is recognised all the world over as the great centre for raw oysters—New York as well as the Southern and Western States depending on it for their supplies. The packing-houses in Baltimore have agencies in all the large cities and towns, and these agencies have sub-agencies covering the country districts. About twenty firms are engaged in the packing and distribution throughout the States of raw oysters, 5,000,000 bushels of which are annually consumed to meet the demands of the trade, which is one not only incurring great risks, but also requiring some tact for its successful management. Such is the perishable nature of the oyster that the risk in handling them has much to do in determining their price. Delays in the arrival of a vessel will often cause a whole cargo to become putrid, so that it has at once to be thrown overboard. To cover these risks the margin of profit is necessarily large. Large numbers of men, women, and children are employed in opening the oysters and removing them from their shells: for this work they receive 20 cents per gallon, and the average earnings of each person are about two dollars per day of ten hours.

In packing the raw oysters they are, after being opened, washed carefully, then placed in flat cans with a little fresh water, as the liquor or natural juice of the oyster decomposes in twenty-four hours after exposure. These cans are then packed in rows with cakes of ice between them, and shipped by express to their destination. At certain points it is arranged that these cases destined for the far west shall be opened, fresh ice placed between the cans, and then re-shipped to their ultimate destination. Oysters packed in this way and re-iced at certain places on the route can be sent from Baltimore to San Francisco in good condition. Besides this trade in raw oysters as many as 3,000,000 bushels are annually steamed and hermetically sealed in tins for shipment to all parts of North America and to Europe. The season lasts from Oct. 1 to April 1. By the steaming process the oysters are so preserved that after being sealed down they will keep good for an indefinite period of time.

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## *RUDE STONE MONUMENTS OR CHAMBERED BARROWS*

### I.

THE object of the present and succeeding articles is to discuss some of the opinions which are held by some of the leading antiquaries of the present day with respect to the construction, destination, and also antiquity of these monuments, and to show that, notwithstanding all the advantages presented by the establishment everywhere of Archæological Societies, the publication of their journals, and the increased facilities for travelling, many professed students of this branch of science are still found to be blindly adhering to the views of antiquaries of the past century. There is a very remarkable contrast between the progress made in the study of unchambered, and in that of chambered, barrows. We have now a much sounder knowledge of the former than of the latter, not simply because the latter are more difficult to understand, but because their study requires qualifications not possessed by every investigator. He must have long acquaintance with the monuments, sufficient dexterity in drawing and surveying to make accurate plans, sections, and elevations, be a close and unbiassed observer, and then have leisure to devote his intelligence to the scrutiny. Cursory examination will be always fatal to the acquisition of sound knowledge, and serve to mislead others; and it is greatly to be feared that this has been too common a habit and result.

The first erroneous opinion to which attention is now directed is that very many of the cromlechs or dolmens (to employ terms which are in general use), *i.e.* rude stone structures which in the British Islands and on the Continent are partially or wholly exposed to view, were never in any other condition; that is to say, that although they may be in some measure dilapidated now, yet that they were originally intended to be exposed buildings. They are aware that many other structures of analogous forms are imbedded or enveloped in mounds so as to be invisible externally, but they will not allow that the exposed ones ever were so. As long as these authors confine themselves to the bare declaration of their belief their position is not so assailable; but when they point to the monuments which they say illustrate their arguments the case is altered. The examples are open to the inspection and consideration of everybody, and the accuracy of their descriptions can be tested. This has been done, and the result has been that numberless inaccuracies have been detected in the published accounts and in the plans; and the conclusions which have been deduced from them are consequently pronounced to be erroneous.

It will be sufficient to point out this in a few of the well-known monuments to which they have directed our attention; and as no author has treated the subject so comprehensively as Mr. Fergusson, or been so methodical in the arrangement and classification of the monuments, his recent work* will be particularly referred to in the following pages. He has admitted that he is indebted for much of his information to the published accounts of others. It must be premised that we do not assert there is positive *proof* of the former existence of the mounds, nor do we say that there is any tradition of them, but we say that when the exposed monuments are compared with those which are wholly enveloped, and with those numberless instances in which the traces, in many examples very extensive traces, of the mounds still exist, the fair and legitimate inference is that these so-called "free-standing" structures† were once monuments of the same class as the others, and that they are only in a more advanced stage of decay at the present time.

We go a step further, and say that there are so *very few* instances in which no trace whatever of a mound remains that the argument from inference is greatly strengthened. Have the advocates of the theory ever attempted to sum up *carefully* all the examples of *total* denudation? It has been remarked by the author of "Rude Stone Monuments in all Countries," p. 44, that "probably at least one hundred dolmens in these islands could be enumerated which have not now a trace of any such envelope." There is a confidence in this statement which invites scrutiny, and we venture to say at the outset that it is far from being accurate, for we know that

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* "Rude Stone Monuments in all Countries, their Ages and Uses."

† These are defined to be dolmens which were never intended to be hidden in any earthen covering, and about which no trace of a mound exists.